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Introduction to the Applications of Plasmonic Metal-semiconductor Hybrid Nanostructures in Solar Energy Harvesting

By

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Abstract

Efficient and extensive harvesting of solar energy is essential to solving energy and environmental crises. Photovoltaics and photocatalysis are two potentially most important means of harvesting solar energy. Sunlight can be absorbed by semiconductors to generate hot electrons and holes, subsequently generating photocurrent in photovoltaics, or, in photocatalysis, driving desirable uphill chemical reactions such as producing hydrogen from water splitting, CO_2 conversion to useful hydrocarbons, and degrading organic pollutants. The interaction of semiconductor with sunlight is rather weak, which severely limits solar energy harvesting efficiency. Au and Ag nanoparticles (NPs)

exhibit strong localized surface plasmon resonance (LSPR) effect, in which the photonic field around NP surface is enhanced dramatically comparing with the far field. Such photonic field concentration leads to light trapping cross-sections much greater than semiconductor NPs, nanowires and organic dyes. LSPR can also result in hot carrier generation and local heating. When integrating plasmonic NPs with semiconductors, LSPR can significantly improve the efficiency of solar energy trapping and conversion. In thin-film solar cells, the strong localization and scattering of incident light by integrating plasmonic NPs can significantly increase light absorption by the semiconductor, thus raise cell efficiency. In photocatalysis, the LSPR of metal NPs can generate hot carriers and inject them into the semiconductor, or enhance the local light field in the adjacent semiconductor which also can yield more electrons and/or holes. Both processes can dramatically promote desirable chemical reactions. I will be briefly review the fundamental physical processes involved plasmonic-based photovoltaics and photocatalysis, and present our preliminary research results.

Biography

Prof. Xuesen Wang is an associate professor in the Department of Physics at the National University of Singapore. He got his PhD in physics at University of Maryland in 1990. Prof. Wang had been Postdoctoral Research Associate at University of California (Santa Barbara) from 1990 to 1992, and University of Minnesota from 1993 to1995, and Assistant Research Scientist at University of Maryland from 1995 to 1997. He was an Assistant Professor at Hong Kong University of Science & Technology from 1997-2001 and at the National University of Singapore from 2001 to 2006, respectively. His research interests include: Growth, in situ low-temperature STM/STS characterization and computational studies of topological insulators, self-assembled and self-organized nanostructures, Metal-semiconductor hybrid nanostructures, and Hybrid organic molecular and inorganic nanostructures studies for their applications in nanodevices and energy harvesting. Prof. Wang had published 75 SCI papers on international-renowned journals, such as PRL and Nano Lett..

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